Carnegie Mellon
Software Engineering Institute

Pittsburgh, PA 15213-3890

Software Outsourcing with CMMI

CMMI Technology Conference
November 2005

Brian Gallagher
Joseph P. Elm
John W. Mishler
SEI Acquisition Support Program

1. REPORT DATE **NOV 2005**	2. REPORT TYPE	3. DATES COVERED **00-00-2005 to 00-00-2005**
4. TITLE AND SUBTITLE **Software Outsourcing with CMMI**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Carnegie Mellon University,Software Engineering Institute,Pittsburgh,PA,15213**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES **5th CMMI Technology Conference and User Group, 14-17 Nov 2005, Denver, CO.**		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **Same as Report (SAR)**	18. NUMBER OF PAGES **48**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

Agenda

SEI Acquisition Support Program (ASP)
Brian Gallagher

- Program Description
- Update on CMMI-AM and CMMI-A

Software Acquisition Survival Skills
Joe Elm & John Mishler

- Examples of practical training approach for Acquirers
- Process Areas and Key Issues for Acquirers
- Symptoms of Problems
- Prevention Strategies
- Suggested Actions
  (depending on where you are in the acquisition process)

Wrap-up
Brian Gallagher

What Does the SEI Acquisition Support Program (ASP) Do?

The Acquisition Support Program (ASP) helps Department of Defense (DoD) and other government acquirers make evolutionary and revolutionary improvements in the acquisition of software-intensive systems, and provides opportunities for SEI programs to create, apply, and amplify new technologies.

Acquisition Business Questions?

"How can I …

… identify and manage the risks that beset my project?"

… develop and manage requirements?"

… create an acquisition strategy best suited for my program?"

… ensure that my software acquisition is integrated with the whole system"?

… create a software architecture that meets the needs of my project?"

… effectively monitor the progress of my acquisition?"

… continuously improve my software acquisition efforts?"
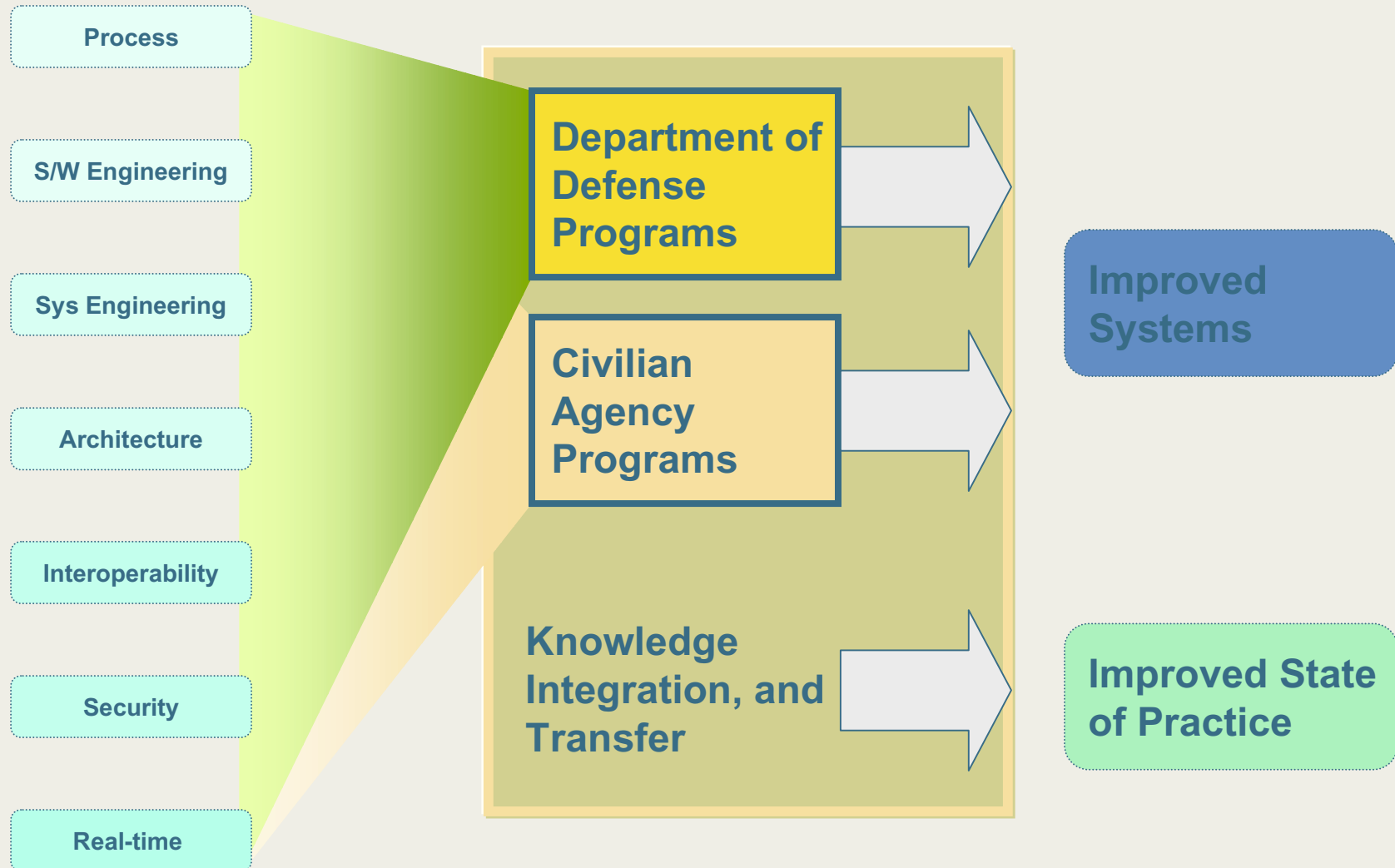
Acquisition Support Program

Purpose

- Accelerate adoption of improved practices for acquiring, deploying, and sustaining software-intensive systems

Tasks

- Enable key acquisition programs to achieve their objectives
- Capture and integrate knowledge from engagements with acquisition organizations

ASP Program Goals

Drawing on our expertise in software engineering, help DoD and other government acquirers improve their ability to acquire, deploy, and sustain systems and capabilities.

Identify opportunities for the Software Engineering Institute (SEI) to create, apply and amplify technologies that respond to customer needs.

Disseminate lessons learned and best practices through courses, workshops, conferences, publications, and participation in acquisition communities of practice.

ASP Program Strategies

- Understand and characterize the acquisition environment (*Needs Analysis*).

- Work directly with key acquisition programs to help them achieve their objectives (*Acquisition Improvement*).

- Disseminate lessons learned and best practices through courses, workshops, conferences, publications, and participation in acquisition communities of practice (*Knowledge Integration and Transfer*).
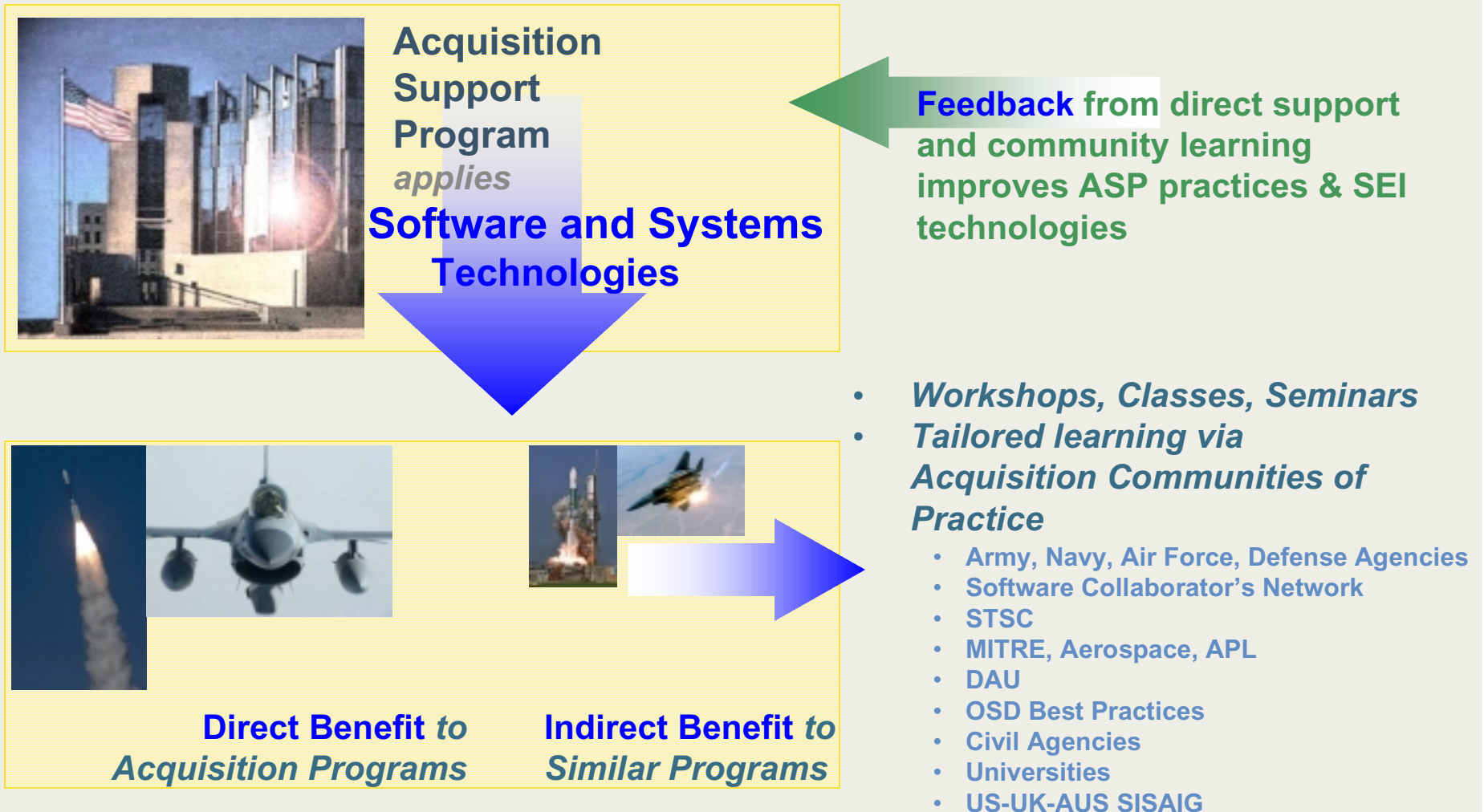
ASP Operational Approach

**Acquisition
Support
Program**
applies
**Software and Systems
Technologies**

Feedback from direct support
and community learning
improves ASP practices & SEI
technologies

Direct Benefit *to*
Acquisition Programs

Indirect Benefit *to*
Similar Programs

- *Workshops, Classes, Seminars*
- *Tailored learning via*
  Acquisition Communities of
  Practice
  - **Army, Navy, Air Force, Defense Agencies**
  - **Software Collaborator's Network**
  - **STSC**
  - **MITRE, Aerospace, APL**
  - **DAU**
  - **OSD Best Practices**
  - **Civil Agencies**
  - **Universities**
  - **US-UK-AUS SISAIG**

CMMI and Acquisition

- **CMMI Acquisition Module (CMMI-AM)**
    - Example of Create, Amplify, Apply
    - Piloted with multiple DoD program offices
        - Large and small size
        - Various life cycle stages
    - Version 1.1 released in May 2005
    - CMMI-AM course now in curriculum
- **CMMI Acquisition Constellation or CMMI-A**
    - In requirements development phase

CMMI Module for Acquisition ver 1.1 Process Areas

Project Management	**Engineering**	**Support**

Project Management	Engineering	Support
• Project Planning	• Requirements Management	• Decision Analysis and Resolution
• Project Monitoring and Control	• Requirements Development	• Measurement and Analysis
• **Solicitation & Contract Monitoring***	• Verification	• **Transition to Operations & Support***
• Integrated Project Management	• Validation	
• Risk Management		

• Note two new CMMI-AM process areas are in **Bold Type**

Carnegie Mellon
Software Engineering Institute

CMMI Module for Acquisition Ver 1.1 Generic Goals and Practices

Generic Goals	Generic Practices
Institutionalize a Managed Process	Establish an Organizational Policy Plan the Process Provide Resources Assign Responsibility Train People Manage Configurations Identify and Involve Relevant Stakeholders Monitor and Control the Process Objectively Evaluate Adherence Review Status with Higher Level Management
Institutionalize a Defined Process	Establish a Defined Process Collect Improvement Information

CMMI Acquisition Constellation (CMMI-A)

- To be built on common CMMI ver1.2 architecture framework and will include:
    - the primitive or base CMMI model (ver.1.2)
    - groups of amplifications for acquisition
    - groups of elaborations for acquisition
    - groups of additions for acquisition
- Development will be in parallel with CMMI ver.1.2
- Deployment will be after CMMI ver.1.2 is released
    - CMMI ver.1.2 scheduled for release in Q3 or Q4 CY 2006
    - CMMI-A forecast for release sometime in CY 2007

CMMI-A Current Status

- Currently in requirements development phase
- SEI coordinating effort, building upon
    - Existing CMMI Acquisition Module (CMMI-AM)
    - General Motors IT Sourcing expansion
    - Will add government perspectives from both DoD and civil agencies

Software Acquisition Survival Skills

Course developed to integrate key issues identified in government acquisitions. Issues identified via:
- Independent Technical Assessments (ITAs) performed by the SEI
- Informal survey of acquisition professionals
- Literature review

Target audience is acquisition project office staff

Topics include:
- Risk Management
- Systems Engineering
- Architecture
- Process Management

- Pre-Award Activities
- Technical Evaluation
- Metrics
- Requirements Management

SW Survival Skills Modules

Based on
- Review of CMMI process areas and specific practices
- Presentation of acquisition amplifying information
- Identification of symptoms
- Suggesting prevention approaches
- Giving practical tips on what to do next (tailored to where you are in the process)

Today: Two Representative Process Areas

Requirements Management & Risk Management

For each:
- Specific practices
- Sample work products
- Sample key issues
- Symptoms of problems
- Prevention strategies
- What to do now (depending on where you are)

Requirements Management Purpose

The purpose of requirements management is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

For Acquisition, requirements management is applied to the requirements that are received from the requirements development process.

Acquisition Requirements Management

During acquisition, requirements management includes

- the direct management of acquirer-controlled requirements

- oversight of supplier requirements management

Requirements are managed and maintained with discipline so that changes are not executed without recognizing the impact to the project.

Requirements management does not end with the selection of a supplier and an award.

- the acquisition project continues to manage high-level requirements, including changes

- the selected supplier manages the lower level requirements

Carnegie Mellon
Software Engineering Institute

Requirements Management
Goal and Practices

Specific Goal	Specific Practice
Manage Requirements	• Obtain an Understanding of Requirements
	• Obtain Commitment to Requirements
	• Manage Requirement Changes
	• Maintain Bidirectional Traceability of Requirements
	• Identify Inconsistencies Between Project Work and Requirements

Obtain an Understanding of Reqts.

- Establish criteria for distinguishing appropriate requirements
- Establish objective criteria for the acceptance of requirements
- Analyze requirements to ensure that the criteria are met
- Reach an understanding of the requirements with the stakeholders

Typical Work Products

- Lists of criteria for distinguishing appropriate requirement providers

- Criteria for evaluation and acceptance of requirements

- Results of analyses against criteria

- Agreed to set of requirements

Sample Key Issues

Missing stakeholders

Lack of appropriate requirements results in inadequate verification, rework or system rejection

Failure to have a common understanding of requirements

Insufficient analysis techniques

Obtain Commitment to Requirements

- Assess the impact of requirements on existing commitments
- Negotiate and record commitments

Typical Work Products

- Requirement impact assessments

- Documented commitments to requirements and requirement changes

Sample Key Issues

Inadequate assessments

Existing commitments are not well known or defined

Failure to negotiate with balance in mind

Failure to obtain written commitment

Manage Requirements Changes

- Capture all requirements and requirements changes
- Maintain the requirements change history with the rationale for the changes
- Evaluate the impact of the requirement changes from the standpoint of the stakeholders
- Make the requirements and change data available

Typical Work Products

- Requirement impact assessments

- Documented commitments to requirements and requirement changes

Sample Key Issues

Lagging documentation

Failure to plan for and manage the change process

Incomplete impact assessments

Lack of backup plans

Maintain Bidirectional Traceability

- Ensure the source of lower level requirements is documented
- Maintain traceability from a base to derived requirements
- Maintain traceability from a requirement to its allocation
- Maintain horizontal traceability from function to function and across interfaces
- Generate a requirements traceability matrix

Typical Work Products

- Requirements traceability matrix

- Requirements tracking system

Sample Key Issues

Lagging documentation

Missing or ineffective requirements tracking system

Forgetting to verify unwanted features have not been added to the system

Forgetting to verify all required features exist

Identify Inconsistencies

- Review the project's plans, activities and work products for consistency with the requirements and changes
- Identify the source of the inconsistency and the rationale
- Identify and initiate corrective actions

Typical Work Products

- Documentation of inconsistencies including sources, conditions and rationale

- Corrective actions

Sample Key Issues

Waiting too long to identify inconsistencies

Failure to verify that corrective action was completed

Assuming contractor or someone else is handling this

Incomplete documentation

Carnegie Mellon
Software Engineering Institute

Poor Requirements Management ...

Symptoms

- **High levels of re-work throughout the project**
- **Requirements are accepted by staff from any unauthorized sources**
- **"Galloping" requirements creep**
- **Requirements are vague and subject to multiple interpretations**
- **Missed requirements or extraneous (not-needed) requirements**
- **Inability to prove that the product meets the approved requirements**
- **Lack of Non-Functional requirements**
- **Inadequate or missing requirements baselines**

Why should we care?

- **Solutions that don't match user needs or may have to be replaced or retired early**
- **Inability to hold contractor to commitments**
- **Excessive budget consumption**
- **Requirements errors are the most common error & most expensive to fix**
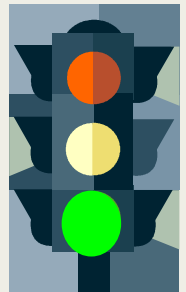 - **Requirements error are likely to consume 25% - 40% of the total project budget when not caught early**

Recovery
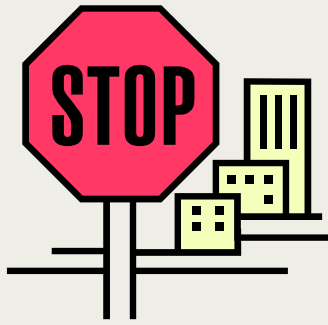
- Assess the situation
- Don't perpetuate the problems
- Select which program elements to continue during assessment and repair

- Use the CMMI Requirements Management Process Area to:
  – Diagnose problem areas
  – Develop corrective action plans

- Baseline the current state, and track changes from there

Prevention Strategies

- Take ownership—
  ## THEY ARE <u>YOUR</u> REQUIREMENTS!

- Develop and manage requirements in a process context

- Ensure your process
  - Avoids key issues
  - Addresses survival tips

- Involve all stakeholders

- Dedicate sufficient resources

What Do I Do Now? 1

If you are in an early program phase:
- Establish a Configuration Control Board
- Ensure that user/operator groups participate in requirements process
- Provide training on "good" requirements and the requirements management process

If you haven't released your RFP:
- Ensure RFP requires documentation of change management and requirements management processes
- Ensure the RFP specifies that the PMO approves a requirements baseline
- Ensure system interface requirements are documented in the RFP
- Ensure RFP addresses the 'ilities' as well as functional requirements

What Do I Do Now? 2

If you are still negotiating the contract:

- Discuss requirements management with the contractor
- Clearly delineate customer/contractor roles regarding requirements development and management
- Potentially modify incentive plan to encourage some of the 'ilities'

If you are already executing the program:

- Can you trace requirements top-down and bottom-up?
- Are software requirements effectively documented and decomposed in order to capture all derived and interface requirements?
- Consider any requirements changes on a case by case basis and consider deferring new requirements
- Are the users/operators still involved as the system is being developed?

Risk Management Purpose

The purpose of risk management is to identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.

Acquisition Risk Management

For Acquisition, risk identification and estimation of probability of occurrence and impact, particularly for those risks involved in meeting performance requirements, schedules, and cost targets, largely determines the acquisition strategy.

The acquirer has a dual role, first in assessing and managing overall project risks for the duration of the project, and second, in assessing and managing risks associated with the performance of the supplier.

As the acquisition progresses to the selection of a supplier, the risk specific to the supplier's technical and management approach becomes important to the success of the acquisition.

Risk Management Goals and Practices

Specific Goal	Specific Practice
Prepare for Risk Management	• Determine Risk Sources and Categories • Define Risk Parameters • Establish a Risk Management Strategy
Identify and Analyze Risks	• Identify Risks • Evaluate, Categorize, and Prioritize Risks
Mitigate Risks	• Develop Risk Mitigation Plans • Implement Risk Mitigation Plans

Determine Risk Sources & Categories

- Determine risk sources and categories

Typical Work Products

- **Risk sources lists (Internal & External)**

- **Risk categories lists**

Sample Key Issues

Including acquiring office risks as well as vendor risks

Not including all stakeholder viewpoints

Skipping ahead to risk identification

Define Risk Parameters

- Define the parameters used to analyze and categorize risks.
- Define the parameters used to control the risk management effort.

Typical Work Products

- **Risk evaluation, categorization, and prioritization criteria**

- **Risk management requirements (control & approval levels, reassessment intervals, etc.)**

Sample Key Issues

Not tailoring risk categories to specific project

Inability to get agreement on risk category thresholds

Skipping ahead to risk identification

Establish a Risk Management Strategy

- Establish and maintain the strategy to be used for risk management.

Typical Work Products

- **Project risk management strategy**

Sample Key Issues

Lack of established process to sustain continuous risk management over time

Failure to evaluate the supplier's risk management approach for the potential of a shared risk data base

Failure to document the strategy

Identify Risks

- Identify and document the risks.

Typical Work Products

- **List of identified risks, including the context, conditions, and consequences of risk occurrence**

Sample Key Issues

Failure to include internal project risks as well as technical risks related to the development

Relying on only one source of risk identification

Failure to distinguish between project risks and project issues

Incomplete risk statements (source, condition, context)

Evaluate, Categorize, & Prioritize Risks

- Evaluate and categorize each identified risk using the defined risk categories and parameters
- Determine the relative priority of each risk

Typical Work Products

- **List of risks, with a priority assigned to each risk**

Sample Key Issues

Inability to achieve consensus on risk categorization

Unclear understanding of categories

Uneven application of risk categories

Develop Risk Mitigation Plans

- Develop a risk mitigation plan for the most important risks to the project, as defined by the risk management strategy

Typical Work Products

- **Documented handling options for each identified risk**

- **Risk mitigation & contingency plans**

- **List of those responsible for tracking and addressing each risk**

Sample Key Issues

Risks without accountability

Unclear understanding of mitigation approaches

Mitigation triggers not communicated

Implement Risk Mitigation Plans

- Monitor the status of each risk periodically and implement the risk mitigation plan as appropriate

Typical Work Products

- **Updated lists of risk status**

- **Updated assessments of risk likelihood, consequence, and thresholds**

- **Updated lists of risk-handling options**

- **Risk mitigation plans**

Sample Key Issues

Lagging documentation

Plans don't match overall strategy set forth for the project

Incentivize risk communication

Poor Risk Management …

Symptoms

- Risks are being ignored
- No activity on documented risk items, static risk database
- Known risks to project staff are a surprise to management
- No risk ownership
- Every time a new problem manifests, a new management technique is tried

Why should we care?

- The project may escape some of the "bullets," but not all of them
- No lessons learned for future projects means making the same mistakes on multiple projects
- Repeated project failures due to unforeseen (but predictable) risks costs you and your organization

Recovery

- Hold a focused working session to
  - Identity, classify, and prioritize all current risks
  - Revise the risk communication and documentation plan
- Consider an independent assessment of program risk
- Develop a distributed risk repository
  - Local risk management at contractor sites and sub-contractor sites
  - Escalate risks according to acquirer approved criteria
- Train project office personnel in risk management
- Hold a risk management review to include a review of mitigation plans

Prevention Strategies[1]

- Start a risk management program on **Day 1** of the program

- Ensure that acquiring office staff has had appropriate risk management training

- Use multiple methods to identify risk sources:
    - periodic risk reporting
    - voluntary risk reporting
    - taxonomy-based questionnaire (TBQ)
    - brainstorming
    - risk report forms
    - TBQ interviews

Prevention Strategies ₂

- Add language to RFPs and contracts that specify how risks are to be reported to the PMO

- Encourage decentralization of risk identification and analysis following an organizationally defined process

- Establish and maintain a schedule of joint risk reviews with all

- contractors throughout the program, including joint prioritization of the most important risks to the program

- Find ways to reward contractors for early identification of issues and risks

- Define a process and criteria for escalating risks to the next higher level

What Do I Do Now? [1]

If you are in an early program phase:
- Establish a PMO risk management process
- Review the acquisition strategy for programmatic risks
- Put PMO risk mitigation plans in place

If you haven't released your RFP:
- Ensure RFP requires explanation/evidence of risk management and mitigation processes and strategies
- Ensure RFP addresses programmatic risks previously identified
- Ensure RFP requires bidders to document risks associated with the program
- Establish a method for evaluating the risk of each proposal

What Do I Do Now? [2]

If you are still negotiating the contract:

- Include a risk management program in the contract
- Ensure risk management tasks/strategy are properly aligned with development and acquisition strategies

If you are already executing the program:

- Communicate regularly with the contractor about program risks and status
- Ensure PMO staff has the knowledge to identify both technical and non-technical risk items
- Consider revising the incentive or award fee to include the risk management program as an incentive area
- Consider conducting independent risk assessments

Summary of Survival Skills Approach

- Review process areas, specific practices, typical work products
- Include Acquisition amplifying information including sample key issues
- Identify symptoms
- List prevention approaches
- Give practical tips on what to do next (tailored to where you are in the process)

Contact Information

Brian Gallagher
Director, Acquisition Support Program
Software Engineering Institute
Tel   412.268.7157
Email   bg@sei.cmu.edu

Joseph P. Elm
Sr. Technical Staff, Acquisition Support Program
Software Engineering Institute
Tel   412.268.9132
Email   jelm@sei.cmu.edu

John W. Mishler
Visiting Scientist, Acquisition Support Program
Software Engineering Institute
Tel   410.414.9219
Email   jmishler@sei.cmu.edu